

## CLAIMS

1. An apparatus (1) to assist a patient respiration by delivering air to this patient through a mask, comprising an air blower (33) wherein the impeller (5) is rotated by an electro motor comprising a rotor (3) and a stator (8), said stator having at least three sectors (8a, 8b and 8c), the rotation of the rotor being enabled by changes of the polarity of the sectors, each sectors, polarity configuration constituting one step of the rotor's rotation, said apparatus comprising a driving unit (36) controlling changes of the sectors polarity configuration such that the electro motor enables the blower to achieve fast accelerations and decelerations within one patient's breath step, said breath step consisting of one inspiration and one expiration ; characterized in that said driving unit comprises means to sense the back electro motor force generated by the electro motor for changing the sectors polarity configuration when the back electro motor force reaches the zero value.

2. The apparatus (1) according to claim 1, wherein said stator (8) has at least three sectors (8a, 8b and 8c), each of said sectors being connected to one switch (HA, HB, or HC) connected to the positive plot of the power supply and each of said sectors being connected to one switch (LA, LB or LC) connected to the negative plot of the power supply, in order that one of the rotor's rotation step is obtained when said driving unit (36) applies the tension to the stator by connecting the first sector (8a) to said positive plot, connecting the second sector (8b) to the negative plot and setting the third sector (8c) not connected to a power supply plot, thus enabling to measure the back electro motor force of the motor between the third sector and the negative plot, said driving unit changing the sectors polarity configuration when the back electro motor force reaches the zero value.

3. The apparatus (1) according to claim 2, wherein said tension applied is a Pulse Width Modulation, the driving unit connecting one of said stator sectors (8a, 8b or 8c) to the

positive plot during a first duration of time and then, and then, during a second period, disconnecting the same sector from the positive plot and connecting it to the negative plot, so that in case of deceleration of the motor the generated  
5 current is sent to the negative plot, thus providing a fast deceleration of the impeller (5).

4. The apparatus (1) according to claim 2 or 3, wherein said stator (8) is a three sectors stator and said rotor is a dipole magnet, said stator thus having six sectors polarity  
10 configuration so that the rotor performs one 360° rotation in six rotation steps.

5. The apparatus according to any one of claims the previous claims, wherein said stator (8) is a toroidal stator and wherein each of said sectors (8a, 8b or 8c) are coils  
15 connected with only one wire.

6. The apparatus according to any one of the previous claims, wherein when the blower (33) is functioning and no back electro motor force is measured, said driving unit (36) fixes the tension applied and changes the sectors (8a, 8b and  
20 8c) polarity configuration after a given time, said driving unit decreasing this given time every step until a back electro motor is detected and then applying the required tension and changing the sectors polarity configuration according to the back electro motor value.

7. The apparatus according to any one of the previous claims, further comprising bearings (4a and 4b) and a bearing holder (93), and wherein said impeller (5), said rotor (3) and the shaft (91) of said impeller are fixed together, said inner ring of the bearings being fixed to said shaft and the outer  
30 rings of said bearings being hold by the bearing holder, which is fixed in the apparatus, and said rotor being shifted outside the stator, preferentially at an equal distance of each of the three stator sectors (8a, 8b and 8c), so that the stator also generates on the rotor an axial force oriented  
35 along said shaft, thus generating a preload on the bearings.

8. The apparatus according to any one of the previous claims, further comprising a power supply manager (29)

connected to the power supply source (30 or 31), said power supply manager comprising a current sensor (55), a comparator (53), a load resistor (54) and a mean to switch on the load resistor between the positive power supply and the ground when the current measured by said current sensor is negative, in order to dissipate this current in said load resistor by thermal effect.

9. The apparatus according to any of the precedent claims, being designed to be connected to a tube of a diameter less than 22 millimeters, a first extremity of the tube being connected to the air outlet of the blower (33) and a second extremity of the tube being connected to a mask in which the patient breaths.

10. The apparatus according to any of the precedent claims further comprising :

- at least one means (110) for detecting the patient's breathing parameters,
- a pressure control unit (37) to adjust the pressure delivered by said blower at the level of said mask, and comprising an estimation module (100) connected to the means for detecting the patient's breathing parameters, in order that the estimation module is able to determine when the patient is inspiring or expiring and in response the pressure to apply to the patient's mask, during inspiration and during expiration.

11. The apparatus according to claim 10, wherein said at least one means detects the patient's airflow and send it to a breath estimator (132) which determines the airflow as a function of time and transmit this function to said estimation module (100) which will thus estimate the pressure to apply to patient's mask according to the airflow function, in order to decrease the effort of the patient's lung while maintaining, during one breath step, the average value of the pressure at the mask  $P_M$  equal to the pressure of treatment, the estimation module (100) preferentially determining the pressure  $P_M$  at the mask as a function of time.

12. The apparatus according to claim 10 or 11, wherein the control unit comprises a non volatile memory in which the clinician can enter clinical settings (120) comprising at least the treatment pressure and possibly the pressure to  
5 apply according to the patient's breathing parameters, said estimation module providing the pressure PM according to these clinical settings and to the patient's breathing parameters.

13. The apparatus according to claim 12, wherein the patient can enter patient settings (122) in said non volatile  
10 memory, said estimation module (100) providing the pressure according to these patient settings and to the patient's breathing parameters within bounds given by the clinician settings (120).

14. The apparatus according to any one of claim 10 to  
15 13, in which the estimation module (100) is able to determine that an event ( $E_1$ ,  $E_2$  or  $E_3$ ) occurs in patient's breathing thus enabling said pressure control unit (37) to provide the blower (33) with the tension to apply to adjust the pressure at patient's mask.

20 15. The apparatus according to any one of claim 10 to 14, wherein said means (22 and 23) for detecting the patient's breathing parameters enable the pressure control unit (2) to compute the airflow at patient's mask, said estimation module (100) determining that an event ( $E_1$ ,  $E_2$  or  $E_3$ ) is occurring  
25 with the airflow parameters or shape.

16. The apparatus according to claim 10 to 15, wherein said estimation module (100) has an inspiration output (102) where said estimation module set the mask pressure PM value during inspiration, and wherein said estimation module has an  
30 expiration out put (104) where said estimation module set the mask pressure PM value during expiration, said pressure control unit (37) comprising a switch (108) which is connected alternatively to the inspiration output or expiration output according to patient's breathing.

35 17. The apparatus according to claim 10 to 16, wherein the means for detecting the patient's breathing parameters comprise a pressure sensor (23) for sensing the pressure at

said first tube extremity and one pressure sensor (22) for sensing the pressure at the extremity of the tube connected to the blower outlet, said airflow computation module being able to calculate the airflow from these pressures and from the tube airflow resistance coefficient KT.

18. The apparatus according to claim 10 to 17, wherein the apparatus further comprises a starting mean which, when actuated, orders the estimation module (100) to detect a breathing activity, said estimator module sending the instruction to stop the blower (33) if no activity is sensed after a given delay.

19. The apparatus according to any one of the previous claims, wherein a power supply manager (29) comprise a communication module (65) which transmits the data through the power source wires.

20. The apparatus according to any one of the previous claims, said communication module (65) comprises a Frequency Shift Keying (FSK) modulator (50) which transforms the binary data sent by the apparatus sensors or elements in a modulation of the frequency of the tension applied on a voltage controlled current source (52), connected to the external power supply, so that the voltage controlled current source transmits the modulation corresponding to the data, a FSK demodulator converting the voltage frequency modulation into binary data (61) and transmits it to the elements, so that each sensor or module connected to the power source is able to receive or transmit information.

21. The apparatus according to any of the previous claims, further comprising a phonic insulation box (34) wherein the blower (33) is placed, said impeller (5) having a size less than 60 mm and comprising between 15 and 45 blades, preferentially 27, so that the impeller rotates at a speed that generates a sound at a high frequency, enabling said box to insulate the patient from this noise.

22. The apparatus according to any one of the previous claims, said apparatus being used for the treatment of breathing anomalies, such as snoring, apneas, or hypopneas.

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23. The apparatus according to claim 5 to 22, wherein said stator (8) is obtained by a strip wound cores technique with a high grade thin silicon steel, of about 0.05 mm thickness.

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